CURRENT SITUATION AND DEVELOPMENT OF BIO-PESTICIDES IN VIETNAM

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1. GENERAL SITUATION

1.1 The role of bio-pesticides in agricultural production

Controlling harmful organisms is one of the most important steps in agricultural production. There have been many measures to control harmful organisms, including chemical pesticides, which play an important role in modern agricultural production. The use of chemical pesticides has brought numerous economic and technical benefits to farmers, effectively protecting the productivity, quality of crops and agricultural products, quickly control harmful organisms, and can stop harmful pests in a short time. Now a day, most countries in the world are using pesticides to control harmful organisms. According to the Food and Agriculture Organization (FAO), in 2015, the global pesticide market is more than USD 35 billion, but also profit over 350 billion USD because the quantity and quality of agricultural products have not been lost due to pests. The great benefits of pesticides toward farmers have been shown globally as well as in Vietnam. In addition to the above priority points, chemical pesticides are the community's concern about food safety issues, export production and environmental pollution. Chemical pesticides often have a wide spectrum of effects; affect many beneficial organisms, organisms that are non-targeted. On the contrary, bio-pesticides are safe and less toxic toward human health, beneficial organisms and the environment, quickly decompose in nature, have a short pre-harvest time, and have little impact on agricultural products therefore suitable to use on clean agricultural products such as vegetables, tea, fruit trees…. Because of these advantages, the development of bio- pesticides, which are environmentally friendly, with strong biological activity, with high selectivity, is an inevitable trend for the development of contemporary pesticides and sustainable agricultural development. Furthermore, many international experts have also pointed out the following main reasons for the increasing use of biopesticides:

1- Due to the need to develop agricultural production in a sustainable direction.

Agricultural production must pay attention to increasing productivity and agricultural output to meet food security needs, while minimizing adverse effects on the environment and adapting to climate change. To meet this requirement, the use of bio-pesticides is the most suitable choice.

2- The trend of domestic and international market is in increasing demand for organic foods that are safe, non-harmful substances.

3- Many large international corporations and enterprises of the world food market tend to trade agricultural products that bio pesticides are applied

4- The laws on food safety and environmental protection of many countries in the world are encouraging producers to use biopesticides instead of chemical ones. In order to ensure the safety of human health and to protect the environment, many countries have tightened the registration of chemical pesticides. Researching

and registering chemical pesticides aremore time-consuming and costly than bio-pesticides.

5- In recent years, scientists in the world have focused on researching and developing a variety of highly effective bio- pesticides with low production costs, easy storage and use.

For these reasons, the development of bio-pesticides is an indispensable trend for the development of biopesticides in the goal of sustainably agricultural development.

1.2. Research, production and use of bio-pesticides in the world

In recent years, biological pesticides are classified into four main categories:

1.2.1 Micro-organism, which contains micro-organism active ingredients, including bacteria, fungi, viruses, protozoa ... Micro- pesticides can be used widely and less costly than other biopesticides.

1.2.2 Biopesticides (Macro- Organisms) in which the composition contains biological agents are living organisms with larger size than microorganisms capable of controlling pests such as nematodes, animal primary ...

1.2.3 Natural Products originate in nature, some compounds are synthesised, some compounds extracted from fermention and some extracted from plants or animals.

1.2.4 Semio chemical pesticides are natural substances such as fatty acids or pheromones (attractants) used to control pests. Semio chemical pesticides include substances that interfere with the growth or mating of pests, and substances that repel or attract pest such as pheromones.

Currently, transgenic plants resistant to pesticides are also considered as control agents for harmful pests.

Based on their effects on harmful pest, biopesticides are also divided into bio-insecticides, bio-fungicides, bio-herbicides, and bio-pesticides on other harmful pests.

1.2.5.Bio-insecticides include the following main types:

-*Bacillus thuringiensis*

- *Beauveria bassiana*

- *Verticillium lecanii*

- *Metarhizium anisopliae*

-Some other types such as: Abamectin, Matrine, Azadirachtin, *Paecilomyces fumosoroseus* and *Aspergillus Flavus*)

1.2.6. Biofungicides include the following main types:

- *Trichoderma harzianum*

-*Trichoderma viride*

- Other microorganisms and herbal extracts prevent pathogenic fungi, microorganisms and plant nematodes

- *Paecilomyces lilacinus and Bacillus firmus* used to control nematodes

1.2.7. Bio-herbicides: Mainly there are two types:

a. Living organisms (fungi, bacteria and viruses).

Bioherbicides (the most common are Phytopathogen pathogens) include genera such as *Colletotrichum, Fusarium, Alternaria, Cercospora, Puccinia, Entyloma,*

Ascochyta and Sclerotinia. These species do not have significant social and economic benefits due to strict environmental requirements and strict technical requirements for the production of biopesticide formulations and storage, etc.

- Bacteria with potential as bioherbicide are mainly *Rhizobacteria,* related mainly to eight genera, including: *Pseudomonas, Enterobacter, Flavobacterium, Citrobacter, Achromobacter, Alcaligenes, Xanthomonas and Erwinia.*

-The finished products of microorganisms *Rhizobacteria* can act directly on seeds and weed seedlings.

- Currently very few Viruses have effect on herbicides.

b. Metabolites of microorganisms: use of toxins and antibiotics produced in the metabolism of microorganisms, including peptides, terpenes, macrocidins and phenolic resins.

The increase of environment awareness, along with the need for sustainable agricultural development, lead to require for development of highly selective and highly bioactive bioherbicides. This is also the inevitable development trend of modern pesticides.

1.3. Research on production and use of biopesticides in the world

In recent years, around the world, there are about 1,400 finished products of bio-pesticides that have been researched, produced, registered and commercialized.

In recent years, the rapid and strong development of new technologies such as molecular biology, genetic engineering, biochemical engineering and others have contributed to the development of biopesticide production. Bio pesticides have attracted special attention and have become the research focus of many leading universities, research institutes and corporations and companies globally.

1.3.1. Results of research on biopesticides of the world in the 1996-2008 period

The ranking results for some of the world's leading bio-pesticides research countries are presented in Table 3.

In the period 1996-2008, the United States was the leading country with 863 articles, followed by India with 64%, less articles than the United States. However, in terms of research quality, Switzerland outperformed all with a citation value / article / year of 3.1. Followed by the UK and the Netherlands with ratio of 2.9 each.

Table 1: List of 10 leading pesticide research countries in the world 1996-2008 period

	Country	**Articles**	**Ranking**	**Articles / year Mean value ± standard error**	**Total quote**	**Quote / article / year The average value ± standard error**
1	United States	863	1(29,3)	66±3,1	11 313	2,4±0,2
2	India	317	2(10,8)	24±3,7	1 076	0,8±0,1
3	England	240	3(8,2)	18±1,8	4 043	2,9±0,3
4	China	188	4(6,4)	14±4,2	473	1,2±0,3

5	Canada	174	5(5,9)	13±1,5	1 285	1,6±0,2
6	Germany	155	6(5,3)	12±1,6	1 737	2,4±0,3
7	France	139	7(4,7)	11±1,3	1 824	2,5±0,3
8	Australia	117	8(4,0)	9±1,1	1 161	2,0±0,3
9	Spain	100	9(3,4)	8±1,7	690	2,1±0,6
10	Brazin	97	10(3,3)	7±1,2	772	1,9±1,0

Research and application of biopesticides of research agencies and organizations around the world have achieved many remarkable results, therefore, bio pesticides have gradually replaced part of chemical pesticides which are highly toxic on the market. In recent years, chemical pesticides production has decreased by 2% / year (Cheng *etal*,, 2010), while the amount of biopesticides has increased by 20% / year. The demand for biopesticides in China is 145,000 tons, while the total revernue was about 0.8 - 1 billion RMB in 2005.

More than 30 State-owned Research Institutes and Research Centers and Chinese Biopesticide Enterprises produce nearly 100,000 tons annually. As of October 2008, 327 bio-pesticides have been registered in China, took 1.6% of the total registered pesticides (Institute for Agricultural Chemical Control, Ministry of Agriculture, 2008).

In India, in 2006, only 12 biopesticides such as *Bt, Trichoderma, Pseudomonas and Beauveria* were registered. In Canada, from 1972 to 2008, the Harmful Pests Administration allowed the registration of 24 active microorganisms with 83 commercial inoculants. Most registrations (55/83) took place between 2000 and early 2008. Mixtures of active ingredients, strains and inoculants are newly registered for use, mainly Bt pesticides, botanical pesticides (rotenone, saponin, matrine, fungicides and plant growth regulators.

1.3.2. Global biopesticide research results 2000-2015

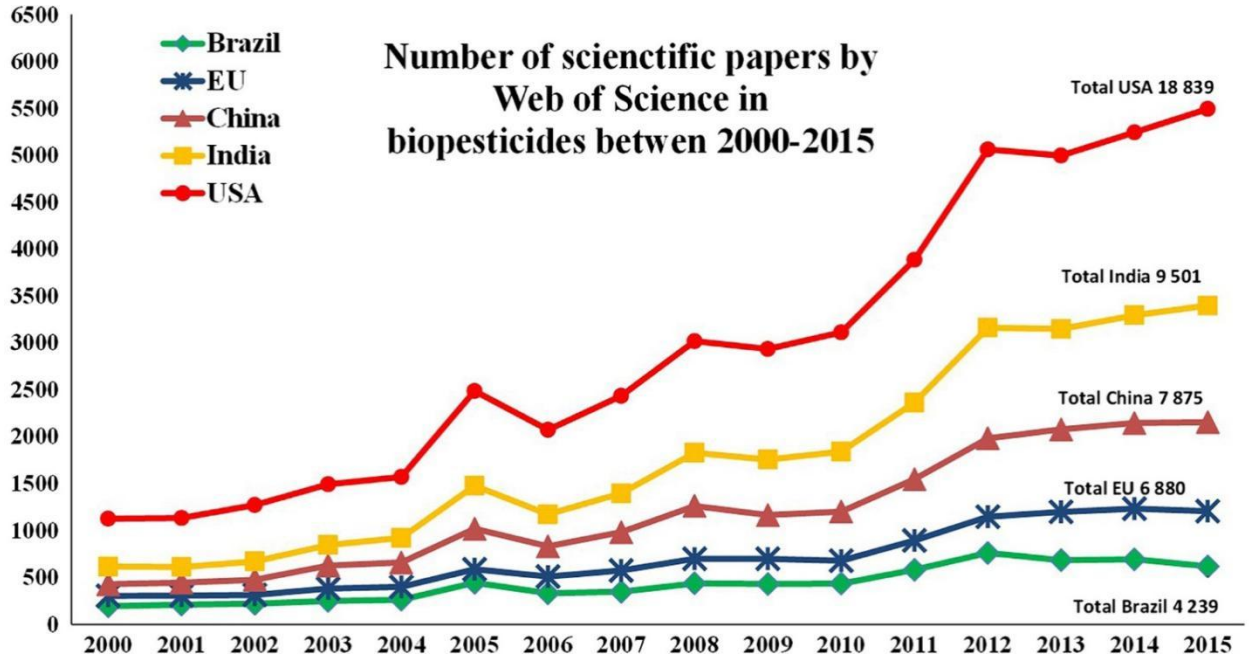

Figure 1. Number of scientific papers on biopesticide in the last 15 years from 2000-2015. Source: Pest Management Science, Volume: 73, Issue: 11, Pages: 2203-2208, First published: May 04, 2017, DOI: (10.1002 / ps.4596) .[5]

As shown in Figure 1, the US is the research leader in biopesticides (18839 articles over 15 years), followed by India and China. Brazil and Europe. In recent years, the US has more research on bio- pesticides than the rest of the world (2012-2015).

As quoted by Le Dang Quang, Tran Dai Lam *et al*.: The cost of researching and developing a biopesticide only takes from $ 3-7 million and takes about 3 years to successfullydevelop and launched[6].

While the cost of developing a new chemical pesticide has increased from $ 152 million in 1995 to $ 286 million in 2014 (Phillips McDougall, 2018). In which the costs related to registration doubled; product development costs increased 34%. However, it does not mean producing a biological pesticide is simple. For a Serenade® product containing Bacillus subtilis strain 713 and Sonata® containing Bacillus pumilus strain 2808, the scientists had to sift through 713 and 2808 different microorganisms (respectively) [6]. For example, companies have successfully screened and commercialized new products containing Bacillus subtilis strain 713 (Serenade®) and through the screening of 713 microorganisms and products containing a Bacillus pumilus strain 2808 (Sonata®) through a screening process for 2808 different microorganisms[6].

Table 2. Successful screening rate of microorganisms with preventive activity biology from sample sources[1]

Bio-pesticide type-object-method	Number of active samples obtained	% success	Sample rate / number of screening samples	Number of screening samples
Herbicide – Leaf Disc	305	1,95	51	15670
Herbicide – Grass Seedling	115	1,19	84	12695
Herbicide - Plant Test Grass	63	2,32	43	2721
Herbicide - Plant Test Broadleaf	19	0,7	144	2729
Insecticide - Beet Armyworm	16	0,1	1002	16037
Insecticide - Lygus	8	0,06	1568	12547
Insecticide - Corn Rootworm	2	0,72	138	276
Fungicide – *Phytophthora*	954	5,74	17	16620
Fungicide – *Monilinia* and *Botrytis*	940	5,65	16	16620
Nematicide	206	2,0	50	9695
Algaecide	83	0,67	150	12419
Bactericide	74	1,38	73	5371
Plant Health (Corn)	108	7,72	13	1399

Table 2 shows successful screening rates for microorganisms with biological preventive activity from primary screening sources. The successful screening rate for insecticide activity is very low from 0.06-0.72%, the herbicide activity is only

from 0.7-2.32% and the fungicide activity is only 0.7-2.32%. The success rate was the highest, about 5% (Table 2).

Table 3. Bio pesticide research and development joint-stock companies that established by major pesticide companies from 2014 to 2019

Company	Year of capital contribution	Value (million USD)	Partner companies	Technology
EcoFlora	2019	Not published	Gowan	Botanical pesticides
Tyratech	2018	Not published	American Vanguard	Essential Oils Pesticides
Ginkgo Bioworks	2018	100	Bayer Crop Science	Biosynthesis produces specific microorganisms
Rizobacter	2016 (50,01%)	Not published	BioCeres	Microorganism
Novozymes	2014	300 to Novozymes	Monsanto	Microbiology (Bio-Ag JSC)

In fact, the successful rate of discovery and commercialization of biological pesticides is higher than that of synthetic active ingredients, but the rate is still very low. There are many complications in evaluating biological effectiveness, examining and evaluating mechanism of action and drug registration process in many regions. However, the numbers of large pesticide manufacturers have recently invested in biopesticide research and development had increased than in the past (Table 3).

Also according to Le Dang Quang, Tran Dai Lam *et al,* (2020): biological pesticides containing active ingredients that are natural compounds accounted for a large market share in 2013. The number of products containing natural active ingredients and synthetic natural compounds accounted for 20% for pesticides, 17% for pesticides, 13% for herbicides and the rest 50% are chemically synthetic pesticides. Natural compounds can be produced by microorganisms and plants. They prevent diseases without using a toxic mechanism like active ingredients in traditional pesticides. However, the natural active ingredients used in traditional pesticides such as pyresthins, abamectin, and spinosads still have neurotoxic effect on insect mechanism and has been used for a long time. Some naturally occurring active ingredients with neurotoxic effects are registered in chemical pesticide. It is difficult to determine the mechanism of action of each natural biopesticide because they are mostly mixed with many active ingredients, with many mechanisms of action on harmful pests, many of their impact have not been clearly defined. Biological herbicides derived from herbs are prepared from extracts or simple substances, and are counted as biological origin, with little impact on human health and environment.

According to Le Dang Quang, Tran Dai Lam *et al* (2020), recent studies of some nano-active substances such as nano chitosan and nano-silver help in effective prevention of plant diseases by a special mechanism with very low content of active

ingredients, which should minimize the impact of chemicals on humans and the environment. Active chemical nanotechnology brings many benefits to formulated pesticides in general and for biopesticides in particular to create biopesticide nano formulation.

1.3.3. Bio- pesticide registration in ASEAN

In 2016, there were 471 bio-pesticides registered in 10 different ASEAN countries, control over 70 harmful pests, of which, Vietnam had 296 registered bio-pesticides, accounting for 62, 8% of bio-pesticide products of the whole region. The harmful pests most registered to control with bio-pesticides are silkworms, then red spiders and thrips.

Table 4. Researched, developed and registered Bio- pesticide products in ASEAN (BCA, 2016)

Bio- péticides	Indonesia	Laos	Malaysia	Philippine	Singapore	Thailand	Vietnam	Total
Pheromones	9	0	0	0	0	0	9	18
Botanical pesticides	16	1	8	0	3	2	60	90
Plant growth regulators	0	2	0	0	0	0	47	49
Micro pesticides	31	6	35	9	7	23	62	173
Natural products	0	2	2	0	1	0	79	84
Mixtures of bio- pesticides	4	3	1	0	0	0	39	47
Messengers	1	0	0	0	0	0	0	1
Total	61	21	46	9	11	26	296	471

Source: BCA, 2016

1.3.4. Important biopesticides research and development activities in recent years

According to Biopesticide Market, 2025, from 2018 to present, many international companies and organizations have registered, developed and marketed many biopesticides in many parts of the world such as: Marone Bio-innovations has cooperated with Chile to develop and distribute two micro insecticides; Andermatt Biocontrol AGs' Madex Top product registered and distributed Madex Top bio-insecticide in Sweden and Israel to prevent pests on fruit trees; Certis USA L.L.C has partnered with Bayer to develop and distribute biopesticides in the US; BASF SE's bio-insecticide Velifer is registered in Australia to control pests on vegetables; Syngenta AG has officially introduced the pesticide Costar with biological agent, *Bacillus spp*., to the market, which is capable of controlling pests on more than 50 crops in EU; Bayer's Bio fungicide Serenade ASO is registered and authorized to sell in France; Certis and Omnilytics of UK joint venture have registered 2 AgriPhage micro-fungicides for anthracnose control in citrus Canker.

Also during the period from 2018 to 2020, some new large-scale, modern biopesticide research institutions have been established, for example, the Koppert Canada Foundation has established a new laboratory in Leamington, Ontario, Canada, this is the modern experimental facility, this is also a bridge between the

manufacturer and the customer . (August 2018), Biological Research Agency Valent has established a new Biological Research Center in Libertyville, Illinois, USA. This is a complex of high-tech laboratories with modern equipment, comfortable working spaces and 20,000 m2 of modern greenhouses (7/2018).

1.4 Global market for biopesticides

Many countries are now encouraging the development and usage of biological pesticides to prevent harmful organisms, contributing to the increase in demand for biopesticides in the next 10 years. Newly produced and registered biological pesticides have increased at a rate of 4% per year.

According to Biopesticide Market Research by Fortune Business Insights Pvt. Ltd, India, the biopesticides grew at an average annual rate of 24% during 2014-2017. In 2011, it was valued at 1.3 billion USD; in 2017, worth 3.36 billion USD; and is forecast to reach 6.42 billion by 2023 and 10.19 billion in 2025.

According to the global biopesticide market in 2017, bioinsecticide and biofungicide accounted for more sales than other biopesticides. Ranking of pesticides by source of active ingredients and harmful agents, micropesticides were the first in terms of sales.

Markets and Markets has researched, analyzed and forecast as follows:

- From 2020 to 2025, the global market share of products of Microbials and Macrobials group (with active ingredients: *Bacillus thuringiensis, Beauveria bassiana, and Metarhizium Anisopliae)* will grow by 15.8%; reaching 2.2 billion USD in 2020 and 4.6 billion USD in 2025.
- The three main types of mushrooms are *Trichoderma sp., Beauveria bassiana and Paecilonyces lilacinus* account for about 7% of market sales.
- Europe and Asia - Pacific are also forecast to be attractive markets thanks to high growth prospects in the coming years.
- Botanical pesticides extracted from plants such as Pyrethrin, Azadirachtin, Matrine and others account for more than 10% of the global sales of biopesticides.
- The global market share of biopesticides will reach USD 1.6 billion by 2020 and forecast to reach USD 3.4 billion by 2025. The growth rate from 2020 to 2025 will reach 16.1%. The biopesticides of all other groups are expected to reach $ 1.2 billion by 2015.
- The global bio-herbicide market reached 800 million USD (2016); 1, 6 billion USD by 2020. Predict their growth rate will reach 14.5%.

In North America, the growing demand for crop products that are free of pesticide residues, coupled with a growing organic food market, plus easier registration for chemical pesticides are important factors to promote the development of the biopesticide market. It is forecasted that the market share of biopesticides in this region will increase continuously from 2021 to 2025 and by 2025 will account for the largest market share in the world.

The US is the largest consumer of biopesticides, accounting for 12% of the global market. The market value of biopesticides in the US is about 205 million USD and will increase to nearly 300 million USD by 2020.

The market for biopesticides of South America in coming time will develop mainly in Brazil and Argentina. In Europe, this market will do better in Eastern Europe than in the EU.

From January to November 2008, biopesticide manufacturing industry in China reached a total value of 9.6 billion Yuan, an increase of 45.2% over the same period last year. Total profit reached 624 million RMB, up 29.98%.

In 2009, in European agriculture, the European Union eliminated many types of chemical pesticides. The governments of Sweden, Denmark, the Netherlands and France recently announced measures to reduce the amount of chemical pesticides used in agriculture by 50%. Rapid development in production of fruit trees and food crops has driven force inpromoting use of biopesticides which gradually replace chemical pesticides. Currently, many countries in this region have actively supported policies and prioritized the development of bio pesticides to promote the development of biopesticide market.

With new regulation banning many synthetic chemical pesticides, the market for biopesticides in EU and Russia region will generally grow well in coming years. China and India are two countries that produce and use the most biopesticides in Asia.

In India, biopesticides are products from Indian oval (Neem), from *Bt, Polyhedrosis virus and Trichoderma* are the main biopesticides being produced and widely used in India. Japan has a turnover of over 9 million USD / year for biopesticides. Europe and Asia - Pacific are also forecasted to be attractive markets thanks to high growth prospects in the coming years.

Botanical pesticides are extracted from plants such as Pyrethrin, Azadirachtin, Matrine and others account for more than 10% of the global sales of biopesticides.

Currently the US, China and Italy are the largest biopesticide producers in the world, accounting for 80% of sales in global market. The US is also the largest consumer of biopesticides, accounting for 12% of global market. The value of biopesticide market in US is about 205 million USD and by 2020 it will increase to nearly 300 million USD. European market for biopesticides reaches nearly 200 million USD. In Asian market, China and India have been using the most biopesticides.

Countries using the most biopesticides are the US, Canada, Mexico, Germany, France, Spain, UK, Italy, the Netherlands, Russia, China, India, Japan, Australia, Indonesia, Brazil, Argentina.

We believe that, with the policies of Vietnamese Government, in near future, we will also includein this list.

1.5. Overview of research, production, sales and use of biopesticides in Vietnam

Biological agents capable of controlling pests such as microorganisms and plants are often available in Vietnam. These products are easy to exploit in large quantities and volumes. Farmers can still use rudimentary processing methods such as going to the fields to collect the pests that have died from fungal diseases, crush them in water and spray them on plants to control the insects. Tobacco plants, pipe tobacco, oval seeds, fish tobacco roots ... are chopped and crushed, soaked in water to get a pesticide solution then spray is also effective method to control pests. However, the

industrial production of biological plant protection products is almost too small and insignificant. Validamycin is a biopesticide product produced by VIPESCO on an industrial scale. Unfortunately, the scale is too small and the high production cost cannot rival imported products.

1.5.1 Outline of some research results, production, trading and use of biopesticides in Vietnam before 2008.

Biopesticide have been researched and put into use in Vietnam since early 80s of the last century and have brought positive effects to farmers, partially reducing environmental pollution. Especially, from 1990 onwards, research and application of biopesticides have been invested by the State and scientific agencies and have obtained initial results.

1.5.1.1. Research on production and use of biopesticides of microbiological origin

In our country, research on insect viruses to insecticides started in 1980. Researches during that time focused on NPV multifaceted virus group. Research on using viruses to prevent pests includes two main contents: research on mass multiplication of host worms by using artificial feed environment and research and development of NPV. The use of virus is successful in preventing some pests such as *Anomis flava; Heliothis armigera; Spodoptera litura*

Bt bacteria are the most important insect pathogenic bacteria. Around the world, Bt is widely studied and used to control many harmful insects. Since Bt was discovered in 1901, it has been used extensively for the control harmful pests in agriculture, forestry and medicine. The main feature of Bt is its ability to synthesize proteins into a poisonous crystal called dendotoxin or cry protein that has insecticidal properties. So far, more than 100 Bt biopesticides have been used against pollen, biracial insects and beetle larvae. Because Bt is very safe for the environment, they are an alternative to chemical pesticides to prevent harmful insects. Bt production research is one of the most successful of the microbiological technology. Currently, Bt inoculants account for nearly 70% of the global biopesticide market.

In Vietnam, besides researching and producing Bt strains domestically (in small quantity), we mainly import Bt inoculants abroad.

From 1971 to 1974, the Plant Protection Institute assessed the effectiveness of imported Bt inoculants such as *Entobacterin, Biotrol, Bacillus serotype 1, Thuricide, Thuringin 150M*. The test results confirmed that these products are highly effective against squamous vermin pests. However, due to limitations in production technology, the production of Bt products on a large scale in Vietnam still faces many difficulties.

Entomopathogenic fungal extracts, *Beauveria bassiana* SG8702 and Paecilomyces fumosoroseus Pfr153, are capable of killing T. cinnabarinus spider eggs.

Two insecticidal fungi preparations successfully studied by Mekong Delta Rice Institute are Ometar (*Metarhizium anisopliae*) and Biovip (*Beauveria bassiana*).

The biopesticides including 10 extracts of the fungus *Beauveria bassiana, Metarhizium anisopliae and Paecilomyces fumosoroseus* have been produced and

tested for bioavailability. Test results have confirmed that this bioinsecticide is capable of killing the eggs of *T. cinnabarinus* red spider.

Since the beginning of 1990, the fungi *Beauveria bassiana, Metarhizium anisopliae, Isaria* have been studied by the Plant Protection institute and faculty of agriculture, forestry and Fisheries, University of Vinh. These fungus have been produced in raw form (mixture of medium and fungal spores). Some preparations have quite high potency against pests such as *Beauveria*, which is effective for 7-10 days to use on scaly beetles that harm vegetables and other plants; preparations *Metarhizium* can be used to prevent yellow-backed grasshoppers; Nomuraea rileyi powder fungus can control green worms, worms and some other vegetable pests; *Beauveria bassiana* birch fungus and *Metarhizium anisopliae* erectile fungus are capable of eliminating many pests and diseases of the scaly beetle (silk worms, green worms, cavities), hard wings (root damage) or straight wings (grasshoppers) ...

Fungal preparations with antagonistic fungi *Trichoderma* except for root rot diseases such as root rot caused by *Phytophthora palmirova*, yellow wilt caused by *Furasium solari, Pythium sp, Sclerotium rolfosii*. This product has been studied successfully in Vietnam.

1.5.1.2. Research, development and use of botanical pesticides

Vietnam is a country with a rich flora with many types of oily plants, essential oils containing various bioactive substances.. This is an important advantage to help develop biopesticides for sustainable agricultural production.

According to many research results, our country currently has up to 53 species of poisonous plants that can be exploited and used as herbicides, including many poisonous plants with high toxicity, easy to grow and exploit, especially nectar plants, jasmine flowers, jicama trees, Indian oval (Neem), derris , tobacco, tobacco, betel nut, grass roots, etc. This is an important advantage, helping to develop biopesticides for sustainable agricultural production. Some botanicale pesticides have been used by people for a long time, such as nicotine extracted from tobacco and Rotenon extracted from derris roots, yam beans and cool beans.

The Indian oval (neem) topped the list of 2,400 plant species capable of killing insects and is considered a source of friendly bio-insecticides. Products from the Indian oval tree (neem) are capable of controlling more than 350 species of arthropods, 12 species of nematodes, 15 species of fungi, 3 types of viruses, 2 species of snails and 1 species of crustacean. Azadirachtin is the main active ingredient extracted from the Indian oval (neem) tree, which can affect the insect's metamorphosis. According to the research results, there are more than 195 insect species resistant to synthetic chemical pesticides but not against Azadirachtin. Pollinators, bees and other beneficial organisms are not affected by the pesticides extracted from the Indian oval (neem) plant.

Since 2002, the Dalat Fruit and Vegetable Association cooperated with the Center for Applied Biochemistry Research Ho Chi Minh successfully studied

Azadirachtin active ingredients in the seeds, dill, and branches of Neem. They have prepared three pesticides, Neemcide 3000EC, Neemcide 3000 SP, and Neemcide 3000 ES, to repel food and kill insects that damage plants and food warehouses. The production of biopesticides has also been interested in researching production and trading by many pesticide companies. VIPESCO has used the seeds of Neem grown in Ninh Thuan to produce bioinsecticides 1500EC and 5000EC which have the effect of eliminating green pests, small worms, fungi and bacteria that cause disease in rice and other crops.

Currently in our country, biopesticides with active ingredients Azadirachtin (extracted from Indian oval tree), Matrine (products of the bitter melon tree), Rotenone (the product of fish medicinal plant) are botanicale pesticides used to thrips control and some other pests on rice, vegetables, fruit trees, tea and many other crops have been registered by many businesses and organizations with different trade names.

1.5.1.3. Production and use of biopesticides originating from nematodes (macro-organisms)

Currently, there are thousands of insect species that are host nematodes. Several species of nematodes have been studied to produce probiotics for pest control. Nematode research for pest control was started in 1997 at the Institute of Ecology and Biological Resources. The Institute has isolated 22 strains of nematodes of the genus *steinernema* and 11 strains of the *genus heterorhabditis*, of which 8 are good bioinsecticides, 4 bioinsecticides developed from nematodes: Biostar-1 (strain S -TK 10), Biostar-2 (strain S-CTL), Biostar-3 (strain (H-HP 11), Biostar-4 (strain H-NT3). Effect of probiotics from nematodes on Green caterpillar Helicoverpa armigera, cavity worm Spodoptera litura, white caterpillar Pieris rapae, silkworm Plutella xylostella reach 63-100% The mechanism of action of the nematode is symbiotic with pathogenic bacteria to create a combination of pathogenic parasites In which the nematodes parasitize and carry symbiotic bacteria into the insect's body, the bacteria that produce toxins to cause disease and kill the insect.

1.5.1.4. Research and use of semiochemical pesticides

Semiochemical pesticides are substances in nature such as plant extracts, fatty acids or pheromones (examples) used to prevent harmful organisms. Biochemical pesticides include substances that interfere with growth or mating, and that repel or attract pests such as pheromones.

Pheromones are substances that carry chemical signals between individuals of the same species, causing specific reactions for other individuals of the same species.

To use pheromoniasis, the following measures can be used:

- Pheromones trap mainly lure males
-The powder has electrostatic properties
-Combination between pheromone and antiseptic
-Combine colored sticky traps and pheromones

There are more than 900 species of pests that can be controlled with pheromones by luring them into traps to kill them.

In Vietnam, the research on synthesis and application of pheromones is currently conducted by the research team at the Institute of Chemistry - Vietnam Academy of Science and Technology, led by Professor Nguyen Cong Hao, focusing on some insects such as *Plutella xylostella*, green worm (*Helicoverpa armigera*), cavity worm (*Spodoptera litura*) ... However, due to complex molecular structure of active ingredients and requires high purity, so synthesizing them requires advanced qualifications and equipment. These products have high cost, limited range of use.

1.5.2. Scientific researches on biopesticides in recent 10 years in Vietnam

According to the National Department of Information Science and Technology, the number of scientific articles related to field of plant protection from 2014 to 2018 in Vietnam is 361 articles. Research topics on preventing harmful organisms by living organisms such as antagonistic microorganisms and natural enemies account for 58%, topics related to active ingredients extracted from herbs 18%, topics about nano active ingredients with 15% bioactive and the remaining 9% are other materials.

In the 10 years from 2009 to 2019, prominent scientific and research topics on biopesticides in Vietnam include: using natural enemies such as spiders to catch prey on *Phytoseiidae* family (2019), antagonistic microorganisms *Bacillus pumilus and Agrobacterium tumefaciens* are endogenous bacteria that can decompose N-acyl-L-homoserine lactones (AHLs) used in the control of plant rot caused by *Erwinia carotovora subsp. carotovora* (2019), *Trichoderma* (2017), Bt insecticide (*Bacillus thuringiensis*) (2017), *Lecanicillium lecanii* fungus for control of pink powder mealybug (*Phenacoccus manihot*i) (2017), nuclear polyhedrosis virus (NPV) for insect control omnivorous cavity (*Spodoptera litura*) (2016), fungus *Metarhizium* (BIOFUN 1) and *Beauveria* (BIOFUN 2) insecticides and aphids (2016), purple fungus *Paecilomyces* insecticide (2016), green mushroom *Metarhizium anisopliae* against aphids (2015), *Streptomyces bacteriophage, Trichoderma* fungus for plant diseases (2015), *Bacillus sp.* except fungi *Fusarium oxysporum, Phytopthora palmivora (2015), bacteria Pseudomonas sp. and Azospirillum sp.* white powder disease control (2015), nano zinc oxide (ZnO), leaf spot disease control (*Cercospora sp.) (2015), a combination of Trichoderma and Pseudomonas* for white rot disease control (2015), microbial preparations - 18 nematode control (2015), *Trichoderma* preparation and recombinant peptide-carrying bacteria (2014), *Metarhizium anisopliae* fungus control aphids (2013), *Lecanicillium spp*, aphid extermination (2013), NPV-Spl (nuclear polyhedrosis virus) (2013), *Pseudomonas putida* antagonistic bacteria for rapid death control (*Phytophthora capsici*) (2013), *Trichoderma* probiotic and phosphonate product (2013), insect fungus *Beauveria, Metarhizium (2010), Trichoderma* to control diseases caused by fungiphytophthora and Fusarium (2009), preparation Metarhiziun anisopliae (2009).

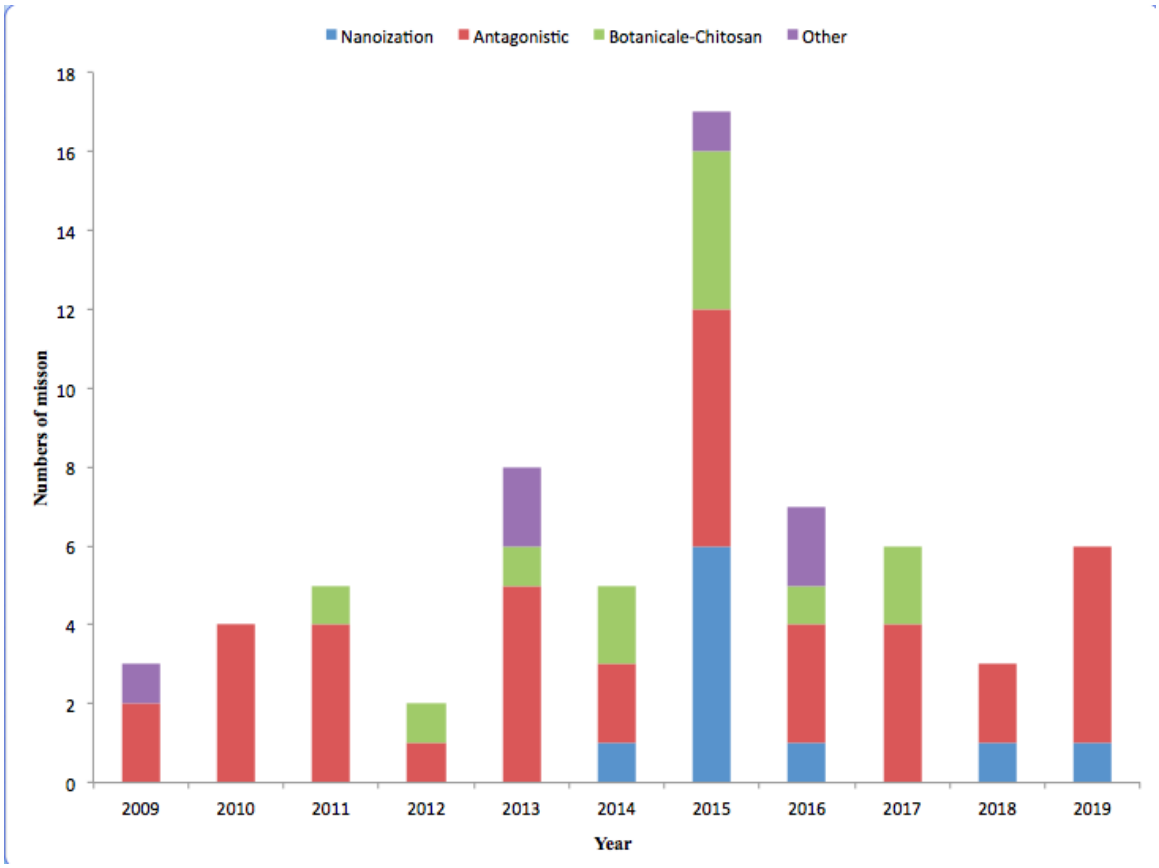

Figure 3. Percentage of research topics on biopesticides completed in Vietnam from 2009-2019 -Source: National Department of Science and Technology Information

According to Tran Dai Lam, Le Dang Quang et al (2020): Research topics on nano active ingredients such as silver / chitosan nanoparticles produced by gamma irradiation (2018), nano zinc - copper fungicidal Phytophthora capsici (2016), bio-synthesized nano co-synthesized in the control of pink fungus caused by Corticium salmonicola (2015), nano MgAl layered double hydroxides (LDH) attached anacardic acid (LA) for pest control (2015), nano-silica and oligochitosan preparations except anthracnose (2015), nano-silver nanocomposite products except plant diseases (2014). Medicines containing nano silver active ingredients such as MIFUM 0.6 DD and Nano Kito 2.6 SL that have been researched and developed recently in Vietnam have been registered for use in Vietnam. However, assessment of safety of nanomaterials, measurement of the characteristics and toxicity assessment of the nanomaterials should be clearly defined byevaluation method. Safety of nanomaterials in the health of humans and beneficial organisms is an issue that requires regulators, scientists, production units and consumers to understand the concept, properties, the relationship between characteristics of nanomaterials, the chemical and biological reactions that nanomaterials can cause on a molecular scale in living organisms (humans and animals, plants).

Some outstanding research about herbal products include: extract containing anthraquinone from rhubarb Rheum sp. as raw materials for production of plant protection drugs (2017), biopesticides products from Cassia alata L. (2016), basil

essential oil (Ocimum basilicum) to prevent red spider (Tetranynchus urticae) 2015 , aryl-chitooligosaccharide derivative for plant diseases (2015), curcuminoids from turmeric for plant disease control (2015), Chitin and Chitosan Oligome preparations (2014), fatty acids and derivatives (2014), use Ant Co (Rhina canthus nasutus) for the production of biological insecticides (2012), herbicide Anisaf SH - 01 2L (2011) (Figure 3).

From the scientific data that has been surveyed, it can be seen that research and development antagonistic microorganisms biopesticides are dominant in Vietnam. Meanwhile, studies on herbal pesticides (12 topics) and nano-active ingredients (10 topics) account for less than 50% of the number of topics on pest control.

1.6. Results of biopesticide production, registration, trading and use in Vietnam

1.6.1. Biological pesticide use in Vietnam

According to report of 10 ASEAN countries in 2016, Vietnam is the leading country in ASEAN in terms of quantity and types of biological pesticides registered and used. According to Department of Plant Protection, biopesticide market of Vietnam in 2019 is estimated to be worth 30.7 million USD and by 2024 it is expected to reach 65.7 million USD, with growth of over 16, 4 years.

Currently, a number of popular biopesticide production technologies in the world have been registered and applied in Vietnam such as: nano biopesticides, Chitosan, NPV multifaceted virus products, microbiological products. bio-products, antagonistic fungi preparations, botanical pesticides.

Some biopesticides active to control harmful organisms have been researched and applied for production and registration, and are allowed to be used in Vietnam such as: Saponin (from oily oil), Matrine (gentian), Eugenol (lychee), Carvacrol (thyme), Polyphenol (Bodhi, Gleditschia australis, Hy Thiem- Siegesbeckia orientalis, flower-Sophora japonica L. Schott, leaf, charcoal bark of mango-Mangifera indica L.), Artemisinin (from the Yellow Flower plant), Cucuminoid (from yellow turmeric), essential oils such as lemon oil, orange, cottonseed oil, lilac oil, tarragon oil ...

However, there are still few Semiochemical products with biological properties such as sex pheromones, and post-harvest preservation pesticides applying for registration.

Currently, the State has many policies to encourage the development of bio-pesticides than chemical pesticides. These priority and encouragement policies include:

- The Government has policies to encourage investment in scientific research and application of modern technology to create less toxic bio-pesticides and methods to manage harmful organisms towards sustainability. .
- The Government has issued Decrees on conditions for pesticide production and trading in order to reduce production conditions for biopesticides. Being exempted from the certificate of eligibility for production but still ensuring the conditions on environment and fire prevention.
- Biopesticides are encouraged to register on all crops; reduce the number of bio-effect tests, testing to determine quarantine period; registration technical

documents; Registration fee are much lower and implementation time duration is much shorterthan that for chemical pesticides.

- According to regulations on transporting dangerous goods, biopesticides are exempted from procedures for licensing to transport pesticides.

1.6.2. Biopesticide registration in Vietnam

1.6.2.1. Register for a license to conduct a plant protection experiment

- In order to promote the development and registration of biological pesticides, in recent years, central agencies to localities have focused on raising awareness of organizations and individuals in the development of biopesticides. Organizations and individuals are also supported with policies and conditions when investing in registration of biopesticides.

- In recent times, number of biopesticides applying for registrationhas been increasing rapidly of which there are many new biological active ingredients used for the first time in plant protection such as: Anacardic acid Laminarin, Verticillium chlamydosporium, Quilajja saponarria, Capsacin, Talin ...

Table 5. Number of biopesticides apply to be registered

Certificates for field trial	Year		
	2017	2018	2019
Number of commercial pesticides applied for fiel trial	35	22	50
Trade names	33	22	47
Total of Active ingredients and agents	22	17	35

Source: Data from Plant Protection Department , Ministry of Agriculture and Rural Development

Currently, the biopesticides apply for registration are mainly concentrated on *Bacillus thuringiensis var Aizawai and Bacillus thuringiensis sub. Kurtaki*, *Bacillus amyloliquefaciens (Bacillus subtilis) QST 713, Spinetoram etc* ... In addition, other biopesticides are also authorized by manufacturers in the world to multinational enterprises and Vietnam to do registration procedures such as 6- Benzylamino-purine, Verticillium chlamydosporium, Methyl butyrate, Papain, Natural rubber, Chromobacterium Subtsugae strain PRAA4-1…

Vietnamese research institutes and research centers have production and application research projects and projects to turn biopesticides into practical agricultural production such as Phyto-M and SH products. -Silu, Capsaicin, Talin, Becberin. Botanicale pesticides are extracted from the eucalyptus tree, cashew silk bark ... These biopesticides had been and are being registered intothe list of pesticides used in Vietnam.

1.6.2.2. List of biopesticides

As of June 2020, the List of Pesticides permitted for use in Vietnam, issued together with the Circular No. 10/2019 / TT-BNNPTNT dated 20/9/2019 bythe Minister of Agriculture and Rural Development, there are 1,084 active ingredients with 4,021 trade names, in which biopesticides have 231 active ingredients with 721 trade names, accounting for 18% of the total number of pesticides on the list.

Biopesticide have been registered mainly in the following three main groups:

- Microbiological pesticides (Bacillus thuringgiensis; Bacillus subtilis, Trichoderma spp, Chaetomium.sp ...): 16.01%
- Botanicale pesticides are extracted from the plants such as, Azadirachtin, Matrine, cinnamon essential oil, Lychnis viscaria ... accounts for 20.35%;
- Biopesticides belong to biochemical group such as Abamectin, Pyrethrins, Spinosad, Validamycin, Ningnamycin, Kasugamycin, Gibberellic acid ... accounting for 63.64%.

Among biopesticides registered and used in Vietnam, biopesticides containing active ingredients Abamectin, Emamectin benzoate, Azadirachtin, Matrine, *Bacillus thuringiensis, Trichoderma sp* are being used the most and most effectively.

Table 6. Structure of pesticides in the List of Pesticides permitted for use in Vietnam

STT	Pesticides	Number of pesticides		Number of bio-pesticides	
		Single and mixtures	Trade names	Single and mixtures	Trade names
1	Insecticides	850	1757	115	411
2	Fungicides	563	1191	89	206
3	Herbicides	235	659		
4	Rodenticides	8	26	1	1
5	Plant growth regulators	52	148	13	61
6	Attractants	8	8	1	1
7	Molluscicides	33	153	6	34
8	Synergists	5	6	3	4
9	Termiticides	15	25	2	2
10	Pesticides for preserve forest products	7	8	1	1
11	Fumigation pesticides	4	10		
12	Pesticides for golf	4	4		
13	Pesticides for Seed treatment	19	25		
14	Pesticides to preserve agricultural products	1	1		
Tổng số		1.804	4.021	231(13%)	721(18%)

Source: Data from Plant Protection Department, Ministry of Agriculture and Rural Development

Table 7. The groups of biopesticides

STT	Pesticides	Number of	Number of active ingredients and agents of

		active ingredients	biopesticides		
			Microorganisms	Biosynthesis	Botanical pesticides
1	Insecticides	115	17	89	9
2	Fungicides	89	19	47	23
3	Rodenticides	1	0	0	1
4	Plant growth regulators	13	0	9	4
5	Attractants	1	0	1	0
6	Molluscicides	6	0	0	6
7	Synergists	3	0	0	3
8	Termiticides	2	1	1	0
9	Pesticides to preserve agricultural products	1	0	0	1
	Total	231	37(16,01%)	147(63,64%)	47 (20,35%)

Source: Data from Plant Protection Department, Ministry of Agriculture and Rural Development

According to Plant Protection Department, currently, in the List of Pesticides used in Vietnam, pesticides are registered to control most of the harmful pests, except for some Emerging pests such as the autumn acacia worm .

Total number of registered harmful organisms is 751 species on 284 different crops, of which biopesticides were also registered to prevent 492 harmful pests on 190 crops, accounting for 65.11% compared with the total number of harmful pests in the List of Pesticides Used in Vietnam. The largest number of registered pests / plants are still insecticides and fungicides.

At present, more than 250 organizations and individuals have registered for biopesticides with one or more trade names on major crops such as rice, vegetables and fruit trees. In particular, the number of biopesticide trade names registered using vegetable plant names accounts for about 50% of the total number of registered biopesticides.

Table 8. Number of pests and plants with registered pesticides.

No	Pesticides	Number of pesticides		Number of biopesticides	
		Pests	Crops	Pests	Crops
1	Insecticides	324	62	240	59
2	Fungicides	387	65	235	47
3	Herbicides	1	36	0	0
4	Rodenticides	1	11	1	1
5	Plant growth regulators	1	45	1	42
6	Attractants	1	28	1	23
7	Molluscicides	1	6	1	4
8	Synergists	8	7	8	7
9	Termiticides	1	9	1	4
10	Pesticides for preserve forest products	5	5	1	1

11	Fumigation pesticides	1	3	0	0
12	Pesticides for golf	4	1	0	0
13	Pesticides for Seed treatment	15	5	3	2
14	Pesticides to preserve agricultural products	1	1	0	0
	Total	751	284	489(65,11%)	188 (66,20%)

Source: Data from Plant Protection Department, Ministry of Agriculture and Rural Development

1.7. Developing biopesticides to control new harmful organisms

Recently, a number of harmful organisms appearance hascaused serious harm to agricultural production. Vietnam should build up a policy to prioritize the development of biopesticides to control them.

- For corn insect acacia: It is necessary to develop biopesticides such as Pheromone, BT, and VBT for sustainable prevention and safety for the environment.

- For cassava leaf mosaic virus disease transmitted by pollen: It is necessary to develop biopesticides such as: Metazhizium, Bauvearia ....

- In order to prevent Golden Snail, it is necessary to look for more biological products with ability to prevent.

- Some diseases causing gums to root rot require registration and use of biofungicides: Trichoderma, Cheatomium. ...

1.8. Export and import of biopesticides

1.8.1. Import

According to data from the Plant Protection Department, biopesticides are mostly imported from abroad to process and packing, so they depend heavily on imported raw materials, copyright, production technology, production costs and product stability.

Biopesticides are often imported from a number of countries such as China, USA, India, Germany, Korea, Thailand, Singapore, Malaysia ... In which, China is the biggest partner, accounting for more 50% of the volume of biopesticides is imported annually. The main biopesticides imported are Abamectin, *Bacillus thuringiensis*, Emamectin benzoate, Matrine, *Trichoderma sp*., Azadirachtin ...

The amount of biopesticides imported annually into Vietnam is about 15,000 tons, accounting for 15% of the total volume of importation pesticides. In which the most pesticides contain Abamectin active ingredient, about 4,800 tons (30% of the total amount of importation biopesticides). In 2019, Vietnam imported 16,110 tons of biopesticides (about 50.8 million USD), accounting for 17% of the volume of imported pesticides. However, biological pesticides with an effective ingredient are microorganisms, most of which are produced domestically, mainly by research institutes, universities and some companies specializing in the trading of biopesticides.

According to Plant Protection Department, on average, our country imports 15,000 tons of biological pesticides annually. This shows that amount of biopesticides has a significant market share in Vietnamese market.

Micropesticides *Bacillus Thuringiensis, Trichoderme sp*. And botanical pesticides produced in Vietnam are also being used more by farmers to control harmful pests on vegetables, coffee and pepper nematodes.

Also according to Plant Protection Department,biopestides were imported into VN with an amount worth 50.8 million USD, which is expected to reach 85.7 million USD by 2024, with growth over 16% per year.

1.8.2. Export

According to Plant Protection Department, every year, Vietnam enterprises still export biopesticides to 9 main countries. The export volume in 2019 is 930 tons (accounting for 8% of the export volume of pesticides). The markets with large import market shares are Taiwan (155 tons), Cambodia (360 tons), Japan (70 tons); Singapore (36 tons), Laos (63 tons), Myanmar (50 tons), China and others. The main exported products are biopesticides containing Abamectin, Emamectin, *Bacillus thuringiensis,* Kasugamycin, Matrine, Validamycin.

2. GENERAL ASSESSMENT

2.1. Advantage

We have a system of legal documents on the management of the production, trading and use of pesticides, in general, relatively complete and complete to meet the needs of social life. The legal document system on pesticides in our country is built on the basis of the guidance of the United Nations Food and Agriculture Organization (FAO), harmonizing the principles of pesticide management of ASEAN countries, international conventions to which Vietnam is a signatory such as the Rotterdam Convention, the Stockhom Convention, the Basel Convention and the Montreal Protocol. The Government of Vietnam has made great efforts to promulgate and perfect the system of legal documents related to the state management of pesticides, creating a legal basis for management and business activities. The use of pesticides includes the Chemical Law 2007, the Plant Protection and Inspection Law, and decrees (Decree 31/2016 / ND-CO, Decree 66/2016 / ND-CP, Decree 123/2018 / ND-CP…) Circular 21/2015 / TT BNNPTNT on the management of pesticides, Circular No. 12/2018 / TT-BNNPTNT on promulgating national standards on pesticide quality, Circular No. 43/2018 / TT-BNNPTNT on pesticide import.

- The List of pesticides Usedand Banned in Vietnam is promulgated annually by the Ministry of Agriculture and Rural Development. It can be said that the list of pesticides permitted to be used in Vietnam is advanced and modern compared to other countries in the region and the world. Technical regulations, Vietnamese standards, quality standards of pesticides, pesticide stores, procedures for checking pesticide use on plants and documents other guidelines from the Plant Protection Department. Annually, the Ministry of Agriculture and Rural Development also issues a list of pesticides permitted for use in Vietnam. This has met the actual requirements of agricultural production in our country. Accordingly, pesticides imported into our country are required to undergo import quality inspection, therefore, unsatisfactory batch of pesticides have been forced to re-export or import for recycling.

- The encouragement and support of research, production and use of bio-pesticides have been included in the provisions of laws, decrees and guiding Circulars. The State, Ministries and branches approve science and technology agencies to research and implement topics and projects under key State, ministerial and grassroots science and technology programs on biopesticide. To create procedural conditions for science and technology agencies and enterprises to cooperate with international organizations to implement research and development projects on biopesticides for agricultural production. According to the statistics of the Ministry of Science, Technology and Environment from 2011 to 2019, there were 17 state tasks related to the research of probiotics for plants, of which 8 were State-level, 8 S&T tasks under the Program. Biotechnology in agriculture, fisheries, an international cooperation mission under the protocol.
- Applied and transferred number of technologies to produce effective and environment-friendly new generation biopesticides in agricultural production such as genetic technology: 48 soybean lines have been applied and workers. generation T7 carrying resistance genes for green pests and fruit flies; 07 tobacco lines K326 and C9-1 transgenic with TMV gene resistant to tobacco mosaic; 08 lines of transgenic cotton with insect resistance; Microbiological technology: production and use biopesticide SH-Lifu (SH-BV1) to control nematodes and pathogenic fungi on coffee and pepper; production of antagonistic fungi products *Trichoderma sp*. Plant disease control (13 pesticides are registered in the List); produced Bt inoculant (Bacillus thuringiensis) for plant pests (40 pesticides are registered in the List). In addition, the technology of producing botanical pesticides such as extracts from Neem (Azadirachtin), homegrown, Bo Ket, Hy Thiem, wild Cucumber, cashew nut shell ... have all been registered and used in the field of plant protection; Nano technology: Silver nanoparticles have been applied and registered in the list of pesticides allowed to be used in Vietnam to eliminate the disease of pink fungus (*Corticium salmonicolor)* on rubber trees and blast disease (*Pyricularia oryzae*), seed blemish (*Alterniria sp., Curvularia lunata; Helminthosporium oryzae, Fusarium sp., Pyricularia grisea ...*) harmful to rice.
- Localities, businesses and people increasingly pay attention to the use of biopesticides in agricultural production, which is an advantage to boost production and use of biopesticides in the coming time.
- Many localities have focused on directing, encouraging and guiding agricultural producers to use biopesticides to control pests.

2.2. Difficulties, problems and challenges in the registration, production, preservation, consumption and use of biopesticides ...

According to statistics, number of biopesticides registered in Vietnam has increased rapidly since 2000ofwhich many products are researched and produced domestically. However, although the number of biopesticides has increased rapidly, sales are only less than 10% of total pesticide sales. In order to minimize the negative effects of highly toxic chemical pesticides on human

health and the environment, we need to speed up their replacement with biopesticides and alternative chemical pesticides. New generation of pesticidesis less toxic to humans, beneficial organisms and the environment.

In addition to their advantages, bio-pesticides also reveal a number of disadvantages such as: High cost, pest control effectiveness of some old biopesticides is limitedand lower than chemical pesticides. The shelf life of many biopesticides is usually shorter than that of chemical pesticides. Farmers have a habit of using fast-acting pesticides, leading to limited quantity and quantity of biopesticides used in production.

Currently, the proportion of biopesticides used accounts for only about 8%-10% of the total annual pesticide quantity due to the following reasons:

- The number of active ingredients of biopesticides is small compared to the actual production requirement
- Due to the lack of equipment and humans,
- Although the technical properties of biopesticides are very high; However, people's knowledge about these products is limited, thus hindering their use.
- Because the process of extraction, fermentation and production of microbiological pesticides in Vietnam is not very stable, product quality is often unstable, toxin content is often reduced after a number of production times.
- Many biopesticides often have high specificity, narrow impact spectrum, slow and unstable effect (due to the influence of many external factors and conditions of use), so they have not been used yet. People prefer to use it as chemical pesticides.
- The cost of using some biopesticides / ha is still high compared to chemical pesticides.
- Although registration procedures for pesticides are easier and simpler than registration for chemical pesticides, there are still a few complicated registration approval procedures that hinder the rapid registration of biopesticides.
- Although funding for the registration of biological pesticides has been greatly reduced compared to chemical pesticides, it still needs to be cut further.

-Because the domestic production of biopesticides has many limitations, although the number of bio pesticides has increased rapidly in recent years, the majority of biopesticides still have to be imported from: China, Japan, Korea, the US ... Biopesticides are difficult to preserve, most of raw materials depend on imports. The product's selling price is still high, and it is difficult to compete with other chemical pesticides. The domestic production of these products is on a small scale, low volume ... high cost cannot rival imported products. The process of filling and packingimported pesticides is likely to be mixed and unclear, especially a mixture of different types: bacteria and viruses. In addition, the State has not yetdevlopeda policy to support capital, factory land, or exemption or reduction of production and consumption tax for biopesticides. The above factors have hindered the production of biopesticides in Vietnam.

- At present, many agricultural producers are not fully aware of the role and benefits of using biopesticides, so they often use chemical pesticides to control harmful organisms.

- The propagation of instructions on the use of biopesticides to agricultural producers is still limited, the instructions are not yet specific, while the use of biopesticides requires a strict application process. more than chemical pesticides (time of use, usage, number of uses…) and the use biopesticides must be synchronous by many households on a large area.

Biopesticides research and experimental topics and projects are still limited and of little interest, especially State-level research topics on biopesticides. High-quality human resources are insufficient, budget is limited, so many research results have not met the needs of agricultural production.

- The system of standards and regulations to check the quality of pesticides over the past years has generally been developed quite sufficiently, however, some test methods are used to determine the specific content for micro-species. Specific organisms such as *Bacillus, Streptomyce*s, and botanical pesticides still have difficulty in the process of setting quality control standards. Therefore, the import, production and regulation of these biopesticides still face difficulties.

- International cooperation in research, transfer and application of biopesticides is also limited.

3. SUGGESTIONS AND RECOMMENDATIONS

In order to increase the production and use of biopesticides,Vietnam pesticide Association would like to providesome suggestions and recommendations as follows:

- Suggest that the Ministry of Agriculture and Rural Development continue to review and propose completion of legal regulations as to create favorable conditions for registration of biopesticides which are safe for humans and the environment. It is necessary to simplify the registration regulations such as shortening process of reviewing/grantingPermit for Pesticide Field Trial, reducing costs for Pesticide Field Trial Permit, Registration Certificate of biopesticides.

- Suggest that the Government, Ministries and branches related to pesticide management to reduce import tax on biological pesticides and biopesticide production technology lines at 0%.

- Propose the amendment, supplementation and reduction of regulations and conditions related to the production and trading tax on biological pesticides. The State should set uppolicies to support capital, lease land for factories, exempt or reduce production and consumption tax for biopesticides.

- Need to supplement and prioritize policies to encourage investment and production; supporting farmers to use biopesticides; funding for agricultural extension programs to effectively apply the results of topics and projects in plant protection; funding for development of national technical regulations, Vietnamese standards related to biopesticides. To promulgate a mechanism to support and encourage the production and use of biopesticides, especially to encourage the use of biopesticides at farm household scales in the locality.

- It is necessary to protect, multiply and supplement natural enemies, considering this as a "natural biopesticide" in the field.
- Propose the amendment, supplementation and reduction of regulations and conditions related to the production and trading tax on biological homestead. The State should developpolicies to support capital, lease land for factories, exempt or reduce production and consumption tax for biopesticides.
- Need to supplement and go underize policies to encourage investment and production; supporting farmers to use biopesticides; funding for agricultural extension programs to effectively apply the results of topics and projects in plant protection; funding for development of national technical regulations, Vietnamese standards related to biopesticides. To promulgate a mechanism to support and encourage the production and use of biological homestead, especially to encourage the use of homestead at farm household scales in the locality.

- Prioritize funding for propagation, dissemination and training of knowledge on biopesticides for plant protection staff, pesticide sellers and pesticide users.
- Suggest all levels of authorities, pesticide management agencies, businesses need to promote the guidance of good agricultural production (GAP) practices, and clean and safe agricultural production to meet the requirements of domestic and foreign markets, and using biopesticides to replace chemical pesticides.
- It is necessary to promote cooperation between management agencies, agricultural production establishments with associations and commodity industries participating in the implementation of the model of using biopesticides, to build up inter-production chain models. Effectively, thereby combining the media to build popular propaganda scenarios to replicate the model across the country.
- Suggest that the two Ministries of Science and Technology and the Ministry of Agriculture and Rural Development prioritize funds to focus on research, development and use of feasible biological pesticides. Strengthen staff training, international cooperation in science and technology in the field of research, production and application of biopesticides in Vietnam.
- The State should encourage enterprises to coordinate with research institutes, universities, and investment research centers, to organize research into the production and use of biopesticides. Currently, biological drugs can not completely replace chemical drugs, so research agencies should also coordinate with businesses to research the harmonious use of chemical pesticides and biological pesticides to pest control aims to both prevent harmful organisms and ensure safety for humans, the environment and export agricultural products.
- Strengthen inspection, examination, and handling of violations of law to minimize the situation of poor quality pesticides.
- Develop a plan, organize the implementation of the signing of a written cooperation agreement between the management agencies specialized in agriculture and rural development with organizations and individuals operating in the field of pesticides on development. biological pesticides, building up production models - using effective pesticides to replicate and apply locally.

- It is necessary to promote international cooperation in order to find the latest technologies, effectively prevent harmful organisms and providingeconomic efficiency, thereby stimulating the development of production and use of biological pesticides in Vietnam.

- It is necessary to cooperate with laboratories of research agencies and companies with foreign biopesticide products to develop methods and standards for quality control of biological pesticides.

- In addition to the elimination of toxic chemicals, Ministry of Agriculture and Rural Development, Plant Protection Department and Pesticide Associations also need to coordinate to organize meetings between Vietnamese pesticide enterprises and Pesticides enterprises foreign countries to create opportunities for business cooperation and search for and develop new generation of biological pesticides and chemical pesticides.

- Vietnam Pesticide Association (VIPA) suggested that t Plant Protection Department continues to preside over and coordinate with pesticide businesses, Croplife and media agencies and other related organizations. Organize communication programs to raise public awareness about the effective and safe use of biopesticides for humans, beneficial organisms and the environment. Strengthen training to improve and change People's awareness and thinking about the role and long-term effects of biological pesticides, gradually shifting from using chemical pesticides to using biological pesticides.

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